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Humbert et al.

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(54) **RESTRAINT SYSTEM PRETENSIONERS**

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Related U.S. Application Data

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(51) **Int. Cl.**

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B60N 2/427	(2006.01)
B60N 2/42	(2006.01)
B60N 2/68	(2006.01)
B60R 22/195	(2006.01)
B60R 22/26	(2006.01)

(52) **U.S. Cl.**

CPC ***B60R 22/4619*** (2013.01); ***B60N 2/4242*** (2013.01); ***B60N 2/42736*** (2013.01); ***B60N 2/688*** (2013.01); ***B60R 22/1953*** (2013.01); ***B60R 22/26*** (2013.01); ***B60R 22/4623*** (2013.01)

(58) **Field of Classification Search**

CPC B60R 22/1953; B60R 22/4623; B60R 22/1952; B60R 22/4619; B60R 22/195; B60R 22/1951; B60R 22/4604; B60R 22/46; B60R 2022/468; B60N 2/4242; B60N 2/42736; B60N 2/42727; B60N 2/427; B60N 2/42

USPC 280/806; 242/374; 297/480

See application file for complete search history.

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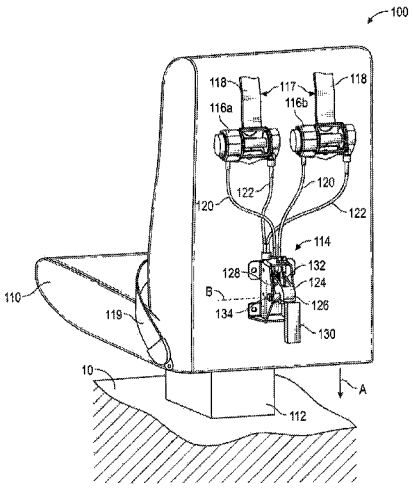
(57) **ABSTRACT**

Various embodiments of restraint system pretensioning devices for use in land, air, and sea vehicles are described herein. In one embodiment, a seat unit for use in a military land vehicle or helicopter includes a stroking device that enables the seat to move downwardly in response to sudden movement. The seat unit also includes a seat belt or harness that extends around the occupant in the seat. Sudden movement of the seat in response to an explosion or hard landing causes a pretensioning assembly to automatically pretension the seat harness.

20 Claims, 8 Drawing Sheets



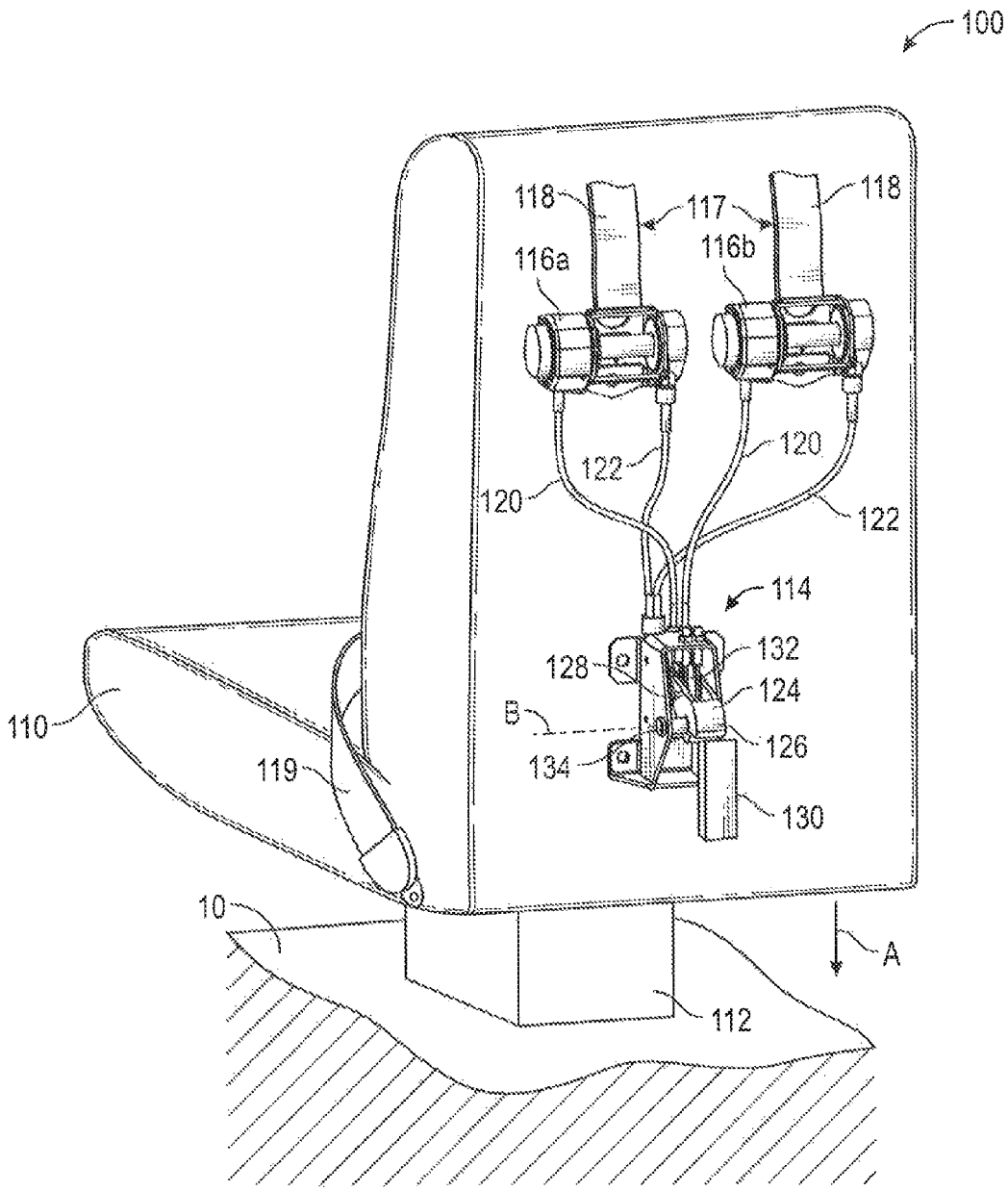

100
118
117
118
116a
116b
120
122
120
122
114
128
132
124
B
126
134
130
110
119
10
A
112

FIG. 1

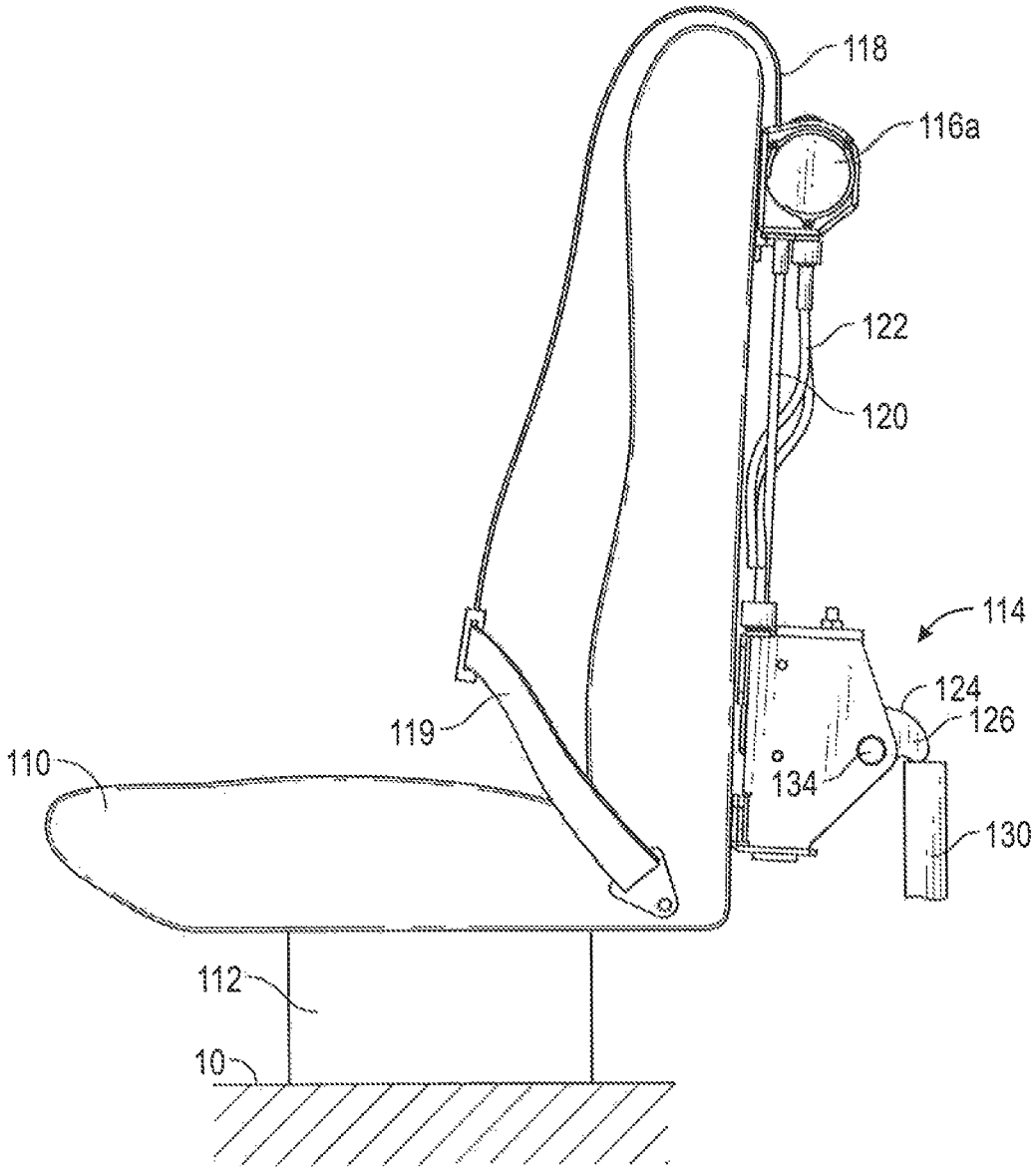


FIG. 2A

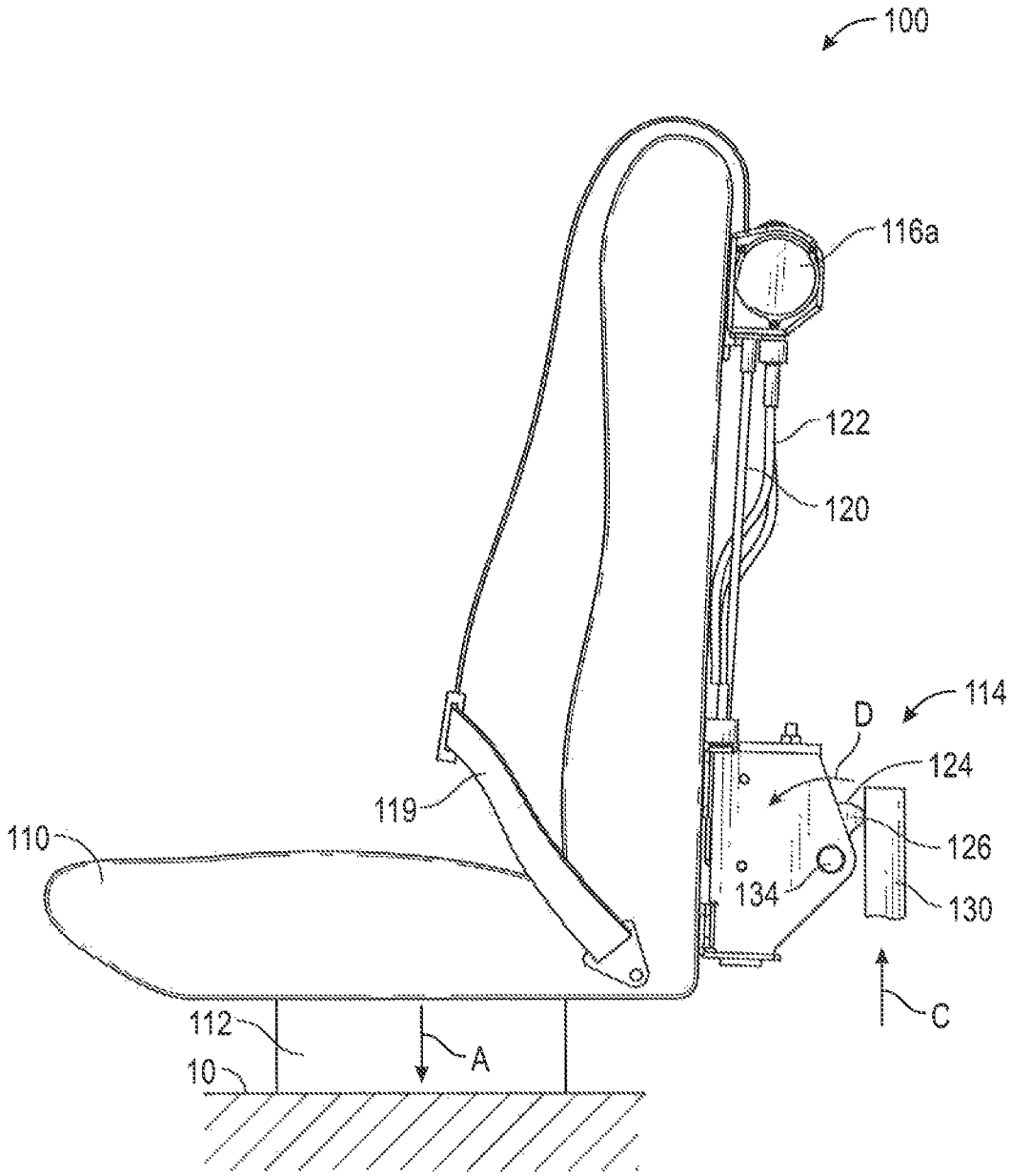


FIG. 2B

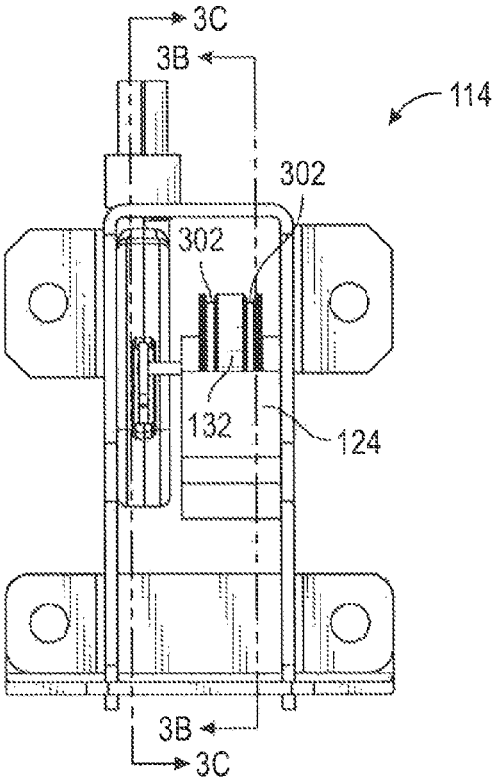


FIG. 3A

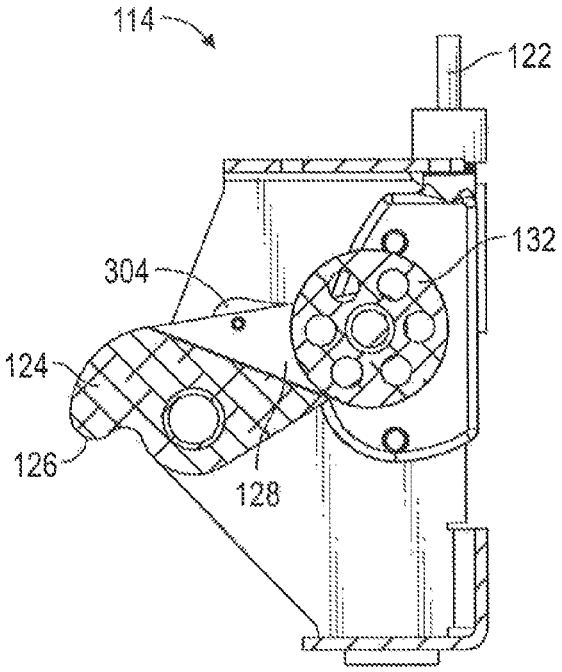


FIG. 3B

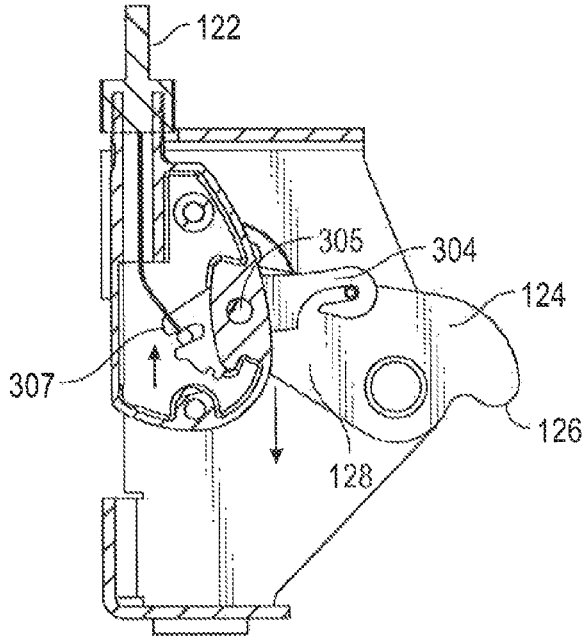


FIG. 3C

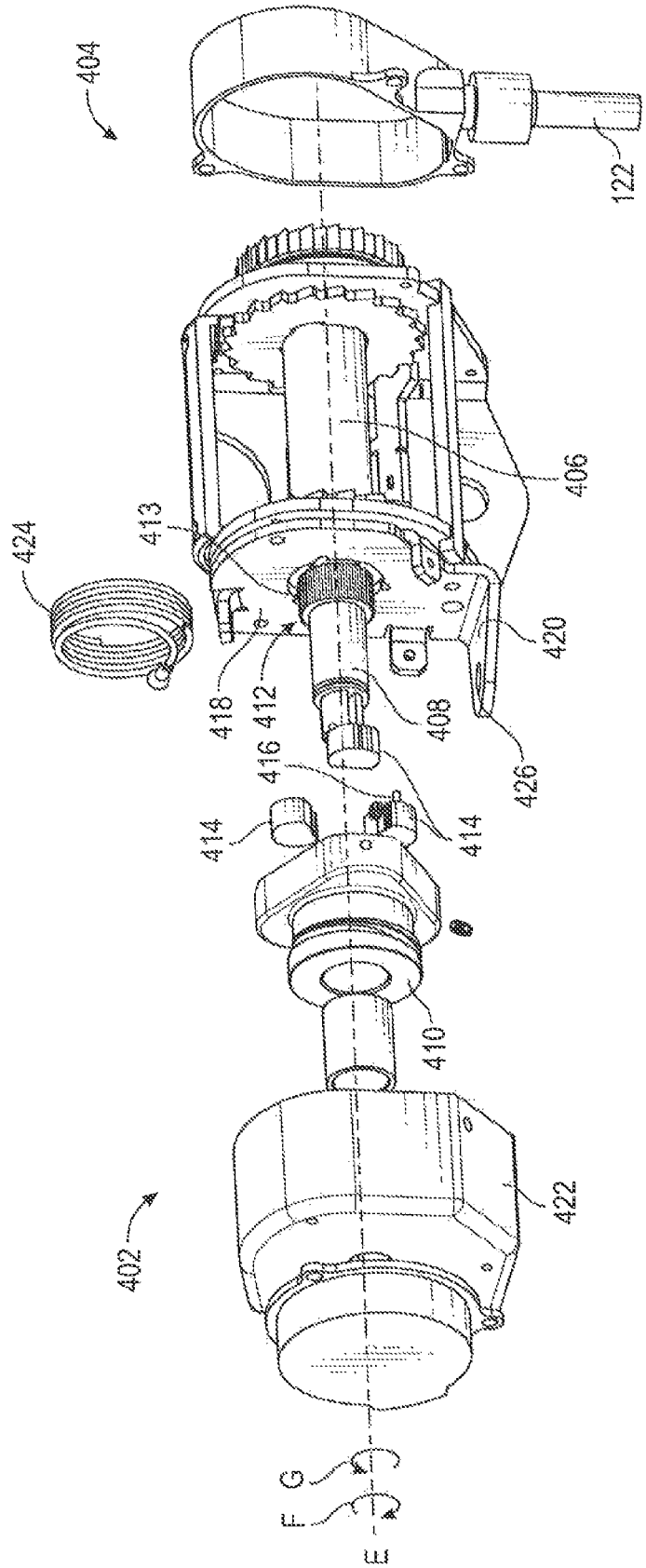

404
122
116
406
413
424
420
418
412
408
416
426
414
414
410
422
402
G
F
E

FIG. 4

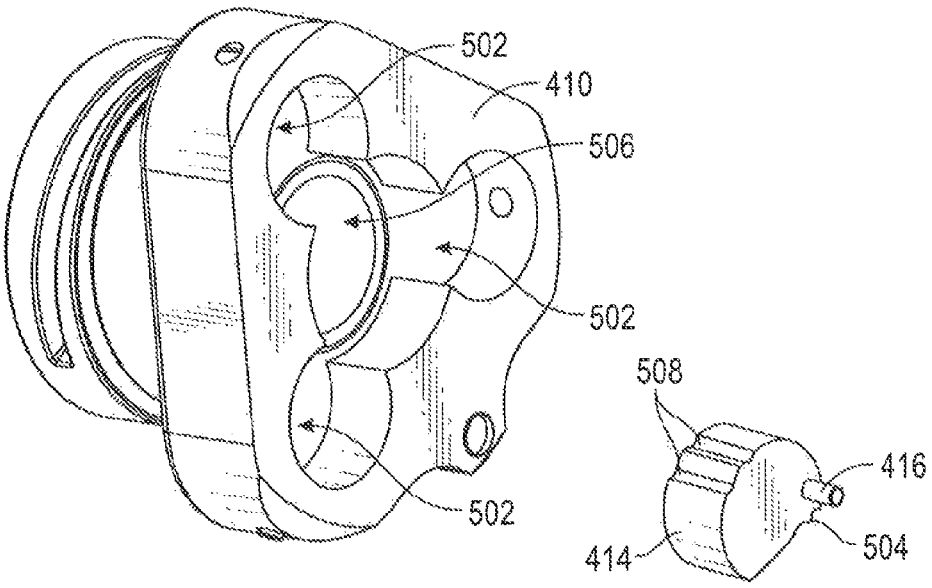

502
410
506
502
508
416
502
504
414

FIG. 5

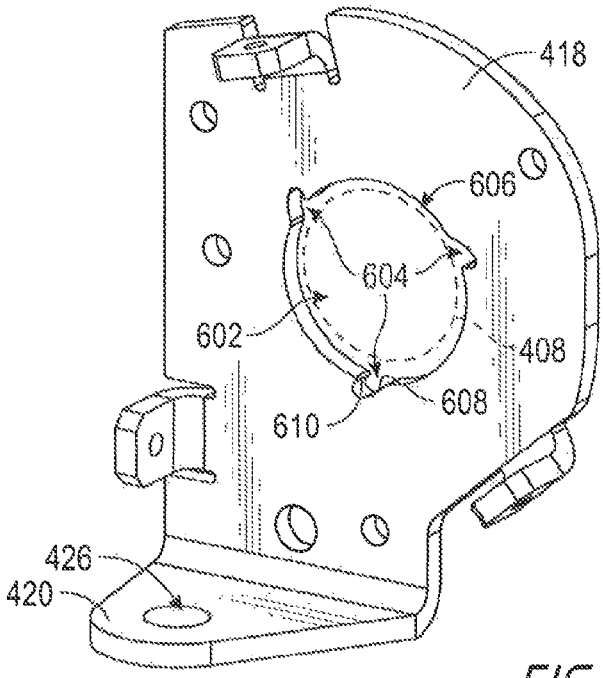

418
606
604
602
408
608
610
426
420

FIG. 6

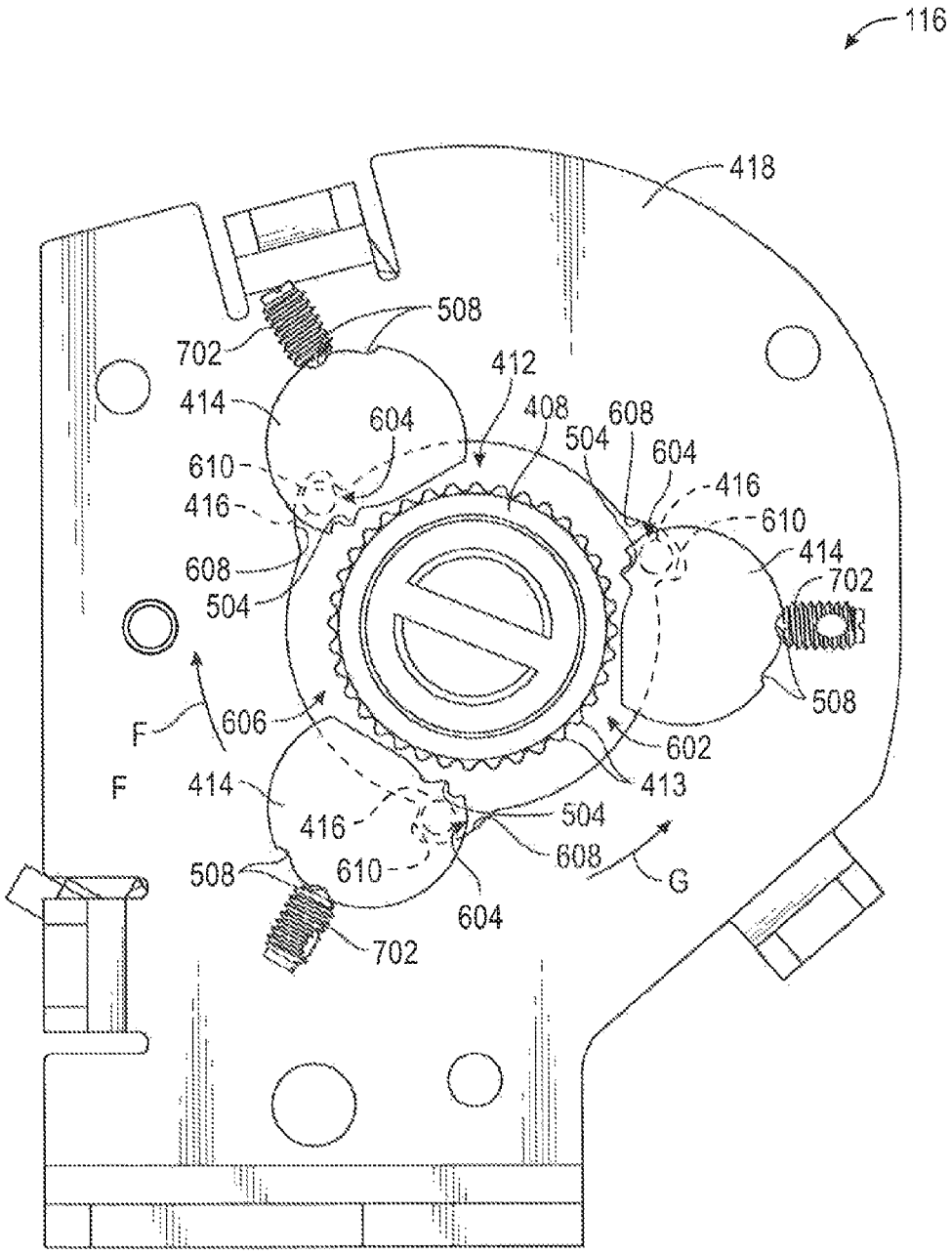


FIG. 7A

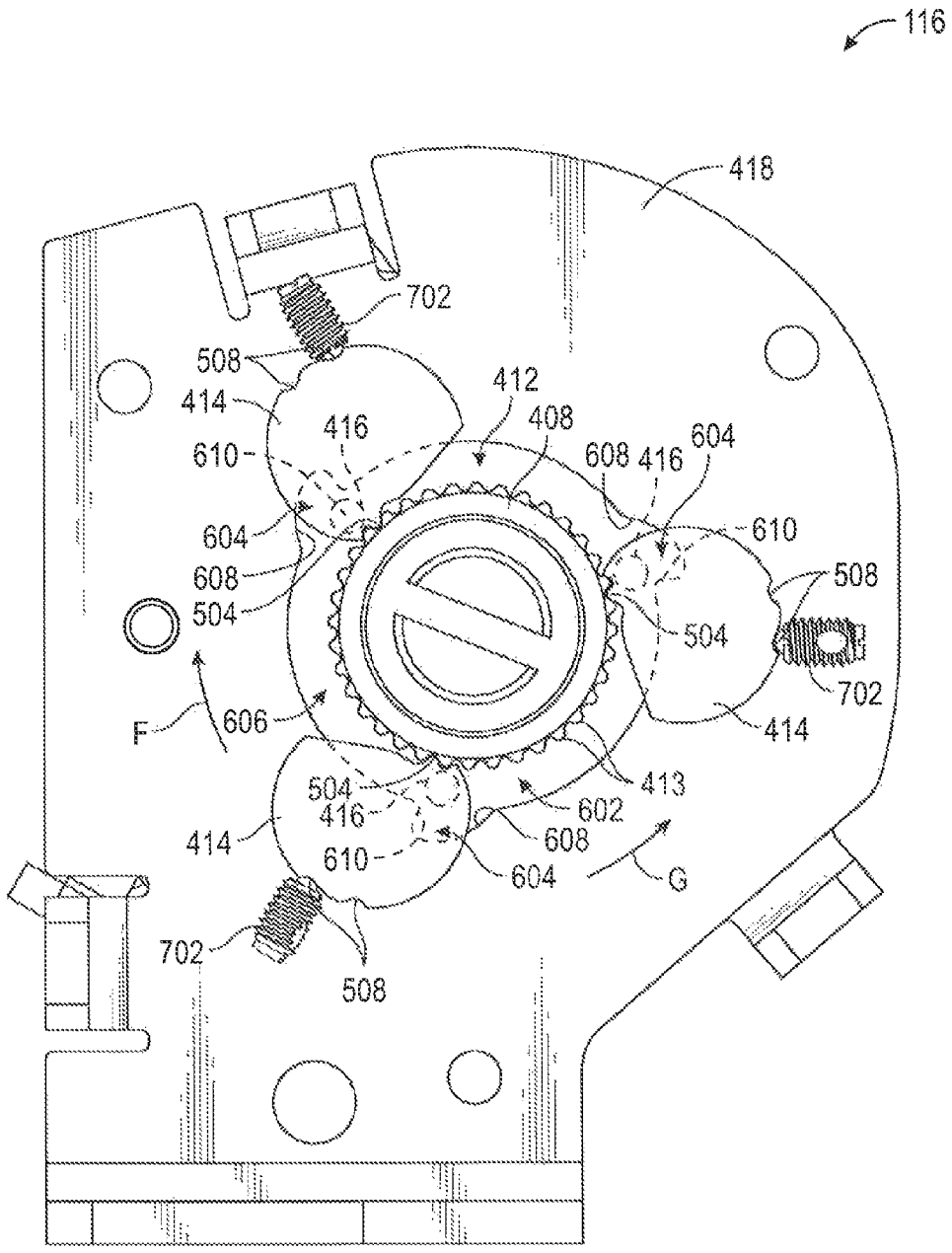


FIG. 7B

RESTRAINT SYSTEM PRETENSIONERS

CROSS-REFERENCE TO RELATED APPLICATION INCORPORATED BY REFERENCE

The present application claims priority to U.S. Provisional Application No. 61/922,700, filed Dec. 31, 2013, and entitled "RESTRAINT SYSTEM PRETENSIONERS," which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The following disclosure is directed generally to the field of personal restraints for use in vehicles and, more particularly, to the field of restraint system pretensioners for use in military land vehicles, air vehicles, and other vehicles.

BACKGROUND

Military land vehicles generally have a three-, four-, or five-point seat/shoulder belt or harness in one or more of the vehicle seats. Civilian vehicles generally have a three-point shoulder belt/lap belt harness. To minimize or reduce injury during a collision or rollover, both military and civilian vehicles have used seat harness pretensioners. In a typical pretensioner, sensors on the vehicle detect the acceleration and/or deceleration forces of a collision or rollover, causing the pretensioners to actuate. The pretensioners then tighten up the seat harness around the seated passenger or driver milliseconds before the actual full impact or rollover. The tightened harness holds the passenger securely into the seat, reducing impact and rebound injuries. These existing pretensioners can be relatively complicated designs because they rely on pyrotechnic devices or electric motors operating a belt retractor, each controlled by an electronic trigger.

Many military land vehicles are designed to resist the destructive forces of mines and improvised explosive devices (IEDs). These explosive devices create unique risks for military land vehicles. Detonation of a large explosive device can generate forces on the vehicle exceeding 100 g, causing the vehicle to accelerate violently upwardly. To reduce the forces on the vehicle crew during a detonation, some military vehicles, such as the Joint Light Tactical Vehicle (JLTV), Bradley Fighting Vehicle, and Mine Resistant Ambush Protected Vehicle (MRAP), have blast attenuating seats. Blast attenuating seats are often supported on shock absorbing materials or are mounted on a shock absorbing structure, such as a stroking device, that allows the seat to move downwardly during a blast.

Conventional harness pretensioning techniques are generally impractical with these types of blast attenuating seats, because the seats move relative to the vehicle body during the blast and the acceleration is largely vertical, rather than horizontal. In addition, conventional harness pretensioning systems typically use pyrotechnic devices, electric retractor motors, or electronic sensors, which can be complicated and costly.

In addition to land vehicles, passengers in helicopters are subjected to similar types of extreme forces during crashes or hard landings. Some helicopters also have seats mounted on a stroking device. The challenges presented in harness pretensioning with blast attenuation seats are also present in helicopter seats mounted on stroking devices.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric view of a vehicle seat having a restraint system pretensioner assembly configured in accordance with an embodiment of the present disclosure.

FIG. **2**A is a partially schematic side view of the seat and pretensioner assembly of FIG. **1** in a neutral position and configured in accordance with an embodiment of the present disclosure.

FIG. **2**B is a partially schematic side view illustrating the seat and pretensioner assembly of FIG. **2**A in a deployed position in accordance with an embodiment of the present disclosure.

FIG. **3**A is a front view of a loading mechanism configured in accordance with an embodiment of the present disclosure.

FIGS. **3**B and **3**C are cross-sectional side views of the loading mechanism of FIG. **3**A configured in accordance with an embodiment of the present disclosure.

FIG. **4** is an exploded isometric view of a locking retractor configured in accordance with an embodiment of the present disclosure.

FIG. **5** is an isometric view of a hub and a ratchet configured in accordance with an embodiment of the present disclosure.

FIG. **6** is an isometric view of a locking plate configured in accordance with an embodiment of the present disclosure.

FIGS. **7**A and **7**B are side views of several components of a locking retractor configured in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

The present disclosure describes various embodiments of restraint system pretensioners for use with personal restraint systems in land, air, and sea vehicles. In one embodiment, for example, a seat unit for use in a land vehicle or helicopter includes a stroking device that enables the seat to move relative to the vehicle in response to an explosion or hard landing. The seat unit also includes a tensioning web or belt that is integral with a harness that extends around the seat occupant. Movement of the seat relative to the vehicle in response to sudden movement of the vehicle caused by an explosion or hard landing causes the tensioning belt to automatically pretension the seat harness. The various embodiments described herein can include devices, components or features that are at least generally similar to those described in U.S. Pat. No. 8,469,401, entitled "SEAT HARNESS PRETENSIONER," filed May 17, 2011; U.S. Pat. No. 8,649,400, entitled "SEAT HARNESS PRETENSIONER," filed Feb. 23, 2010; and U.S. Patent Application No. 61/154,731, entitled "SEAT HARNESS PRETENSIONER," filed Feb. 23, 2009; all of which are incorporated herein by reference in their entireties.

Certain details are set forth in the following description and in FIGS. **1**-**7**B to provide a thorough understanding of various embodiments of the disclosure. Other details describing well-known structures and systems often associated with vehicle seats, seat stroking devices, web retractors, seat harnesses, and other personal restraint devices. have not been set forth in the following disclosure to avoid unnecessarily obscuring the description of the various embodiments of the present disclosure.

Many of the details, dimensions, angles, and other features shown in the Figures are merely illustrative of particular embodiments of the disclosure. Accordingly, other embodiments can add other details, dimensions, angles, and features without departing from the spirit or scope of the present disclosure. In addition, those of ordinary skill in the art will appreciate that further embodiments of the invention can be practiced without several of the details described

below. In the Figures, identical reference numbers identify identical, or at least generally similar, elements.

FIG. **1** is an isometric view of a seat **110** having a restraint system pretensioner assembly **100** configured in accordance with an embodiment of the present disclosure. The seat **110** is mounted in a vehicle **10** and is movable vertically in response to a sudden impact, explosion, or other sudden acceleration or deceleration (in a vertical direction). The seat **110** can include a stroking device or stroking mechanism **112** which may be provided in any form that moves or allows the seat **110** to move vertically downward relative to the vehicle **10** in the direction of arrow A during a detonation, explosion, or other event that suddenly accelerates the vehicle **10** upwardly. As used herein, downward means generally in the direction of gravity. With the vehicle in a normal upright position, for example, downward is shown by the arrow A in FIG. **1**.

As discussed above, stroking devices generally allow a seat to move downwardly during an impact. In some embodiments, however, stroking devices such as the stroking mechanism **112** can be configured to permit the seat **110** to be movable in other directions, such as fore and aft, side to side, or any combination thereof. The stroking mechanism **112** accordingly may be attached to the back, the bottom, or even the sides of the seat **110**. In addition, some blast resistant seats configured in accordance with embodiments of the present disclosure can be suspended within the vehicle **10**. The pretensioners shown in the drawings and described herein may be used with virtually any such type of blast resistant seat.

The pretensioner assembly **100** can include a loading mechanism **114** and locking retractors **116** (identified individually as a first locking retractor **116***a* and a second locking retractor **116***b*), all of which can be mounted to the seat **110**. Although referred to herein as the locking retractors **116**, as further described below, the locking retractors **116** can provide for pretensioning and/or locking. The assembly **100** can also include a restraint harness **117** having shoulder straps **118**. The restraint harness **117** can be mounted to the seat **110** and operably coupled to the retractors **116**. The harness **117** extends upward from the retractors **116** and the shoulder straps **118** pass over a top of the seat **110**. In several embodiments, the shoulder straps **118** can be integrated with other portions of the harness **117**. For example, in some embodiments, the shoulder straps **118** can be coupled to a lap belt portion **119** of the harness **117**.

The assembly **100** can also include pretensioning cable assemblies **120** and locking cable assemblies **122** that can operably couple the loading mechanism **114** to the retractors **116**. The pretensioning cable assemblies **120** and the locking cable assemblies **122** can be constructed in a variety of suitable manners to transmit motion from the loading mechanism **114** to the retractors **116**. In the illustrated embodiment, for example, the pretensioning cable assemblies **120** and the locking cable assemblies **122** are Bowden cable assemblies that each include an outer cable guide or housing and an internal cable. The loading mechanism **114** includes a pivotable arm **124** having a first end portion **126** and a second end portion **128**. The arm **124** rotates about a pivot **134** having an axis B that is generally parallel with a base of the seat **110** and perpendicular to the stroking motion of the seat **110**. The first end portion **126** is positioned to contact a fixed portion **130** of the vehicle **10**, and the second end portion **128** is coupled to a pulley **132** that is in operable engagement with the pretensioning cable assemblies **120**. The fixed portion **130** does not move relative to the vehicle **10** when the seat **110** moves up and down via the stroking mechanism **112**.

As described in greater detail below, when the seat **110** moves downward relative to the vehicle **10**, the fixed portion **130** urges the first end portion **126** to pivot upwardly, and the second end portion **128** moves downwardly with the pulley **132**. The downward motion of the pulley **132** pulls on the pretensioning cable assemblies **120** causing retraction of the shoulder straps **118** into the retractors **116**. The downward motion of the second end portion **128** transmits a pushing force on the locking cable assemblies **122**, locking the retractors **116** and preventing outward extension of the shoulder straps **118**.

FIG. **2**A is a partially schematic side view of the seat **110** and the pretensioner assembly **100** in a neutral position and configured in accordance with an embodiment of the present disclosure. FIG. **2**B is another partially schematic side view illustrating the seat **110** and the pretensioner assembly **100** in a deployed position in accordance with an embodiment of the present disclosure. Referring to FIGS. **1**, **2**A and **2**B together, when the seat **110** moves relative to the vehicle **10** in the direction of arrow A, the fixed portion **130** of the vehicle **10** moves upward relative to the seat **110** as shown by the arrow C. This upward relative movement causes the fixed portion **130** to contact the first end portion **126** of the arm **124** and the arm **124** rotates about the pivot **134** as shown by arrow D. When the arm **124** rotates, the second end portion **128** moves the attached pulley **132** downwardly.

FIG. **3**A is a front view of the loading mechanism **114** configured in accordance with an embodiment of the present disclosure. In the illustrated embodiment, the pulley **132** includes grooves **302** to engage and guide the internal cables of the pretensioning cable assemblies **120**. FIGS. **3**B and **3**C are cross-sectional side views along the lines **3**B-**3**B and **3**C-**3**C, respectively, of FIG. **3**A, and illustrating several components of the loading mechanism **114** configured in accordance with an embodiment of the present disclosure. In the illustrated embodiment, a rocker arm **304** is operably engaged with the pivotable arm **124**. As shown in FIG. **3**C, movement of the second end portion **128** of the pivotable arm **124** downward causes the rocker arm **304** to rotate above a pivot point **305**, urging a distal end portion **307** of the rocker arm **304** upward to push on the inner cables of the locking cable assemblies **122**. Movement of the locking cable assemblies **122** can engage components of the retractors **116** to lock the retractors **116** and prevent outward motion or payout of the shoulder straps **118**.

FIG. **4** is an exploded isometric view of the locking retractor **116** configured in accordance with an embodiment of the present disclosure. In the illustrated embodiment, the locking retractor **116** includes a spool **406** that is attached to a shaft **408** that extends through the retractor **116**. The shaft **408** and spool **406** can rotate about an axis E to pay out or retrieve the shoulder straps **118**. In particular, clockwise rotation about the axis E in the direction of arrow F pays out the shoulder straps **118**, while counter-clockwise rotation about the axis E in the direction of arrow G retracts the shoulder straps **118**. The retractor **116** can include a pretensioning portion **402** and a locking portion **404**. The locking portion **404** can include components (e.g., gears, pawls, springs, etc.) that operate to lock the retractor **116** in response to motion (e.g., pushing motion) of the locking cable assembly **122**. In several embodiments, the retractor components that operate to lock the retractor **116** in response to motion of the locking cable assembly **122** can be con-

ventional components arranged in a conventional manner well known to those of skill in the art.

The pretensioning portion **402** can include a hub **410** that can be rotatably positioned on the shaft **408**. A plurality of ratchets **414** having pins **416** are positioned at least partially within the hub **410** and can releasably engage with teeth **413** of a gear **412** on the shaft **408**, as described in more detail below. The pretensioning cable assemblies **120** (FIG. **1**) can include an internal pretensioning cable **424**, a portion of which wraps around the hub **410**. The shaft **408** extends through a locking plate **418** having a tab **420**. A portion of the internal cable **424** can extend downward through a cable opening **426** in the tab **420** and into the external guide of the pretensioning cable assembly **120** (FIG. **1**). In response to downward motion of the pulley **132** (FIG. **1**), a portion of the internal cable **424** is pulled downward through the cable opening **426**, unwinding at least a portion of the internal cable **424** from the hub **410**, and thereby rotating the hub **410** and the associated ratchets **414** about the axis E in the direction of arrow G. The rotation of the ratchets **414** around the shaft **408** in the direction of arrow G causes the ratchets **414** to engage with the shaft **408**, resulting in corresponding rotation of the shaft **408** in the direction of arrow G to retract the shoulder straps **118**, as described in more detail below. A cover **422** can be positioned to at least partially enclose several of the components of the pretensioning portion **402**.

FIG. **5** is an isometric view of the hub **410** and a ratchet **414** configured in accordance with an embodiment of the present disclosure. In the illustrated embodiment, the hub **410** includes a plurality of ratchet pockets **502**. The ratchet pockets **502** are positioned around a shaft opening **506** and can rotatably receive the ratchets **414**. The hub **410** can be positioned on the shaft **408** with the gear **412** aligned with the ratchet pockets **502**. Each of the ratchets **414** can include one or more features that engage the gear teeth **413**. For example, in the illustrated embodiment, each of the ratchets **414** can include at least one ratchet tooth **504** that engages the gear teeth **413**. Additionally, each of the ratchets **414** can include detents (e.g., two detents **508**) that can assist in the rotational positioning of the ratchets within the ratchet pockets **502**, as described in more detail below.

FIG. **6** is an isometric view of the locking plate **418** configured in accordance with an embodiment of the present disclosure. In the illustrated embodiment, the locking plate **418** includes an aperture or opening **602**. The shaft **408** can extend centrally through the opening **602**, creating an annular gap or track **606** between the shaft **408** and the sidewall or sidewalls of the opening **602**. The sidewall or sidewalls can define the opening **602** which can include a plurality of notches or recesses **604** positioned along the circumference of the opening **602**. The recesses **604** can have a sloping portion **608** and a catch portion **610**. When the hub **410** is positioned on the shaft **408** with the ratchets **414** positioned within the ratchet pockets **502**, the pins **416** of the ratchets **414** extend at least generally parallel to the axis E (FIG. **4**) and into either the recesses **604**, or into the track **606**.

FIG. **7A** is a side view of several components of the retractor **116** configured in accordance with an embodiment of the present disclosure. In the illustrated embodiment, the ratchets **414** are positioned around the shaft **408** and within the ratchet pockets **502** (not shown in FIG. **7A** for clarity). During normal operation of the vehicle **10** (e.g., with the seat positioned as shown in FIG. **2A**), the ratchets **414** are generally positioned as shown in FIG. **7A**, with the pins **416** extending into the recesses **604**, and the ratchet teeth **504** disengaged from the gear teeth **413**. Each of the ratchet pockets **502** includes a corresponding set screw **702** (e.g., a spring loaded set screw or a ball-nosed spring plunger) that engages with the detents **508** of the corresponding ratchet **414**. The set screws **702** can at least partially maintain the rotational position of the corresponding ratchets **414** within the associated ratchet pockets **502**. With the components positioned as shown in FIG. **7A**, the shaft **408** and the spool **406** (FIG. **4**) are free to rotate in the direction of arrow F to pay out the shoulder straps **118**.

FIG. **7B** is a side view of several components of the retractor **116** configured in accordance with an embodiment of the present disclosure. Referring to FIGS. **2B**, **4**, **5**, **7A** and **7B** together, when the vehicle **10** experiences an event that results in the seat **110** moving to the position shown in FIG. **2B** (e.g., an explosion that accelerates the vehicle **10** in a vertical direction), downward motion of the internal cable **424** through the cable opening **426** rotates the hub **410** and the ratchets **414** around the shaft **408** in the direction of arrow G. As the ratchets **414** move in the direction of arrow G from the position shown in FIG. **7A**, the associated pins **416** are brought into contact with the sloping portions **608**, forcing the pins **416** into the track **606** and rotating the ratchets **414** within the associated ratchet pockets **502**. The rotation of the ratchets **414** within the ratchet pockets **502** brings the ratchet teeth **504** into contact with the gear teeth **413**, "locking" the hub **410** to the shaft **408**. The tolerance between the pins **416** and the track **606** can help to maintain the rotational position of the ratchets **414** within the ratchet pockets **502**, such that the teeth **504** maintain engagement with the gear teeth **413**. As the hub **410** is further rotated in the direction of arrow G by the downward motion of the internal cable **424**, the pins **416** travel along the track **606**, and the ratchet teeth **504** drive the gear teeth **413**, thereby rotating the shaft **408** and the attached spool **406** in the direction of arrow G. The rotation of the spool **406** in the direction of arrow G retracts the shoulder straps **118** and pretensions the restraint harness **117**.

In some embodiments configured in accordance with the present technology, the pretensioner assembly **100** can be reset to allow for pretensioning in a second event that follows a first or initial pretensioning event. For example, after a first event that pretensions the restraint harness **117**, and when the retractor **116** is no longer locked via the locking cable assemblies **122**, the shoulder straps **118** can be paid out via rotation of the shaft **408** in the direction of arrow F. In particular, when the ratchet teeth **504** are engaged with the gear teeth **413** (as shown in FIG. **7B**), rotation of the shaft **408** in the direction of arrow F can push the gear teeth **413** against the ratchet teeth **504**. The exertion of the gear teeth **413** includes a component of force that pushes the ratchets **504** outwardly, pushing the pins **416** against the sidewalls of the opening **602**. While the pins **416** are in between the recesses **604**, the pins **416** are maintained in the track **606** by the sidewalls of the opening **602**. When the pins advance to a position adjacent to the recesses **604**, the pins **416** move outwardly and are caught by the catch portions **610**. The catch portions **610** engage the pins **416** (as shown in FIG. **7A**), rotating the ratchets **414** within the ratchet pockets **502** (FIG. **5**) to disengage the teeth **504** from the gear **412**. These and/or other steps may be performed to prepare the pretensioner assembly **100** and the seat **110** for a subsequent or second pretensioning event.

Although the components and features of the embodiments illustrated in FIGS. **1-7B** are shown in various arrangements and positions, other configurations of the components and features of the present technology are within the scope of the disclosure. For example, although particular embodiments described herein include three

ratchets arranged around a shaft, alternative embodiments may include more or fewer ratchets. Similarly, the shapes and sizes of the ratchets, the ratchet pockets, and/or other components can be altered and still fall within the scope of the present disclosure. Additionally, the positioning of components described with respect to particular embodiments herein may be altered in alternative embodiments. For example, locking retractors in accordance with the present technology may have gears that are positioned internal to a shaft. Moreover, the gears may be integral with a shaft, or they may be operably coupled to a shaft. While the pretensioner assemblies described herein include ratchets, hubs, and various other components, pretensioner assemblies in accordance with the present technology can include additional and/or fewer components arranged in a variety of suitable configurations.

From the foregoing, it will be appreciated that specific embodiments of the invention have been described herein for purposes of illustration, but that various modifications may be made without deviating from the spirit and scope of the various embodiments of the invention. Additionally, aspects of the invention described in the context of particular embodiments may be combined or eliminated in other embodiments. Furthermore, while various advantages associated with certain embodiments of the invention have been described above in the context of those embodiments, other embodiments may also exhibit such advantages, and not all embodiments need necessarily exhibit such advantages to fall within the scope of the invention. Accordingly, the invention is not limited, except as by the appended claims.

We claim:

1. A restraint system pretensioner assembly comprising:
- a loading mechanism having a movable arm and a pulley;
- a retractor having a spool configured to receive a strap of a restraint harness; and
- a cable operably coupling the loading mechanism to the retractor, wherein the cable is operably engaged with the pulley, and wherein movement of the arm rotates the pulley to retract the cable and rotate the spool to retract the strap.

2. The restraint system pretensioner assembly of claim **1** wherein the retractor includes a hub rotatably coupled to a shaft, wherein the spool is attached to the shaft, and wherein retraction of the cable rotates the hub to rotate the shaft and retract the strap.

3. The restraint system pretensioner assembly of claim **2** wherein the shaft includes a gear, and wherein the retractor further includes a ratchet operable via the hub to engage the gear and rotate the shaft.

4. A restraint system pretensioner assembly comprising:
- a loading mechanism having a movable arm;
- a retractor having a spool configured to receive a strap of a restraint harness;
- a pretensioning cable operably coupling the loading mechanism to the retractor, wherein movement of the arm retracts the pretensioning cable and rotates the spool to retract the strap; and
- a locking cable operably coupling the loading mechanism to the retractor, wherein movement of the arm operates the locking cable to prevent payout of the strap.

5. A restraint system pretensioner assembly comprising:
- a loading mechanism having a movable arm;
- a retractor having:
  - a spool configured to receive a strap of a restraint harness;
  - a shaft, wherein the spool is fixedly attached to the shaft;
  - a gear operably coupled to the shaft;
  - a hub rotatably coupled to the shaft; and
  - a plurality of ratchets operably coupled to the hub; and
- a cable operably coupling the loading mechanism to the hub, wherein movement of the arm retracts the cable, and wherein retraction of the cable rotates the hub to engage the ratchets with the gear and rotates the spool to retract the strap.

6. The restraint system pretensioner assembly of claim **5** wherein individual ratchets include corresponding pins, wherein the retractor includes a locking plate having an opening defined by a sidewall, wherein the shaft extends through the opening to form a track between the shaft and the sidewall, and wherein the pins extend into the track.

7. A pretensioning retractor comprising:
- a shaft extending along an axis through at least a portion of the retractor;
- a gear operably coupled to the shaft;
- a spool coupled to the shaft and configured to receive a strap of a restraint harness;
- a hub rotatably coupled to the shaft and having a ratchet pocket;
- a ratchet having a pin and a ratchet tooth, wherein the ratchet is positionable at least partially within the ratchet pocket with the pin extending at least generally parallel to the axis and the ratchet tooth positioned to selectively engage the gear;
- a cable coupled to the hub and operable to rotate the hub, wherein rotation of the hub engages the ratchet tooth with the gear to rotate the shaft and the spool and retrieve at least a portion of the strap; and
- a locking plate having an opening defined by a sidewall, wherein the shaft extends through the opening to define a track between the shaft and the sidewall, and wherein the pin extends into the track.

8. The pretensioning retractor of claim **7** wherein the opening includes a recess, wherein the pin extends into the recess, and wherein the rotation of the hub moves the pin out of the recess and rotates the ratchet to engage the ratchet tooth with the gear.

9. The pretensioning retractor of claim **8** wherein the recess includes a sloping portion, and wherein rotation of the hub brings the pin into contact with the sloping portion to move the pin out of the recess and into the track.

10. The pretensioning retractor of claim **9** wherein rotation of the hub is in a first direction, wherein the recess further includes a catch portion, and wherein rotation of the hub in a second direction, opposite to the first direction, brings the pin into contact with the catch portion to move the pin out of the track and into the recess.

11. The pretensioning retractor of claim **7** wherein the ratchet pocket is a first ratchet pocket, wherein the ratchet is a first ratchet, wherein the hub further includes a second ratchet pocket and a third ratchet pocket, and wherein the pretensioning retractor further comprises a second ratchet positioned at least partially within the second ratchet pocket and a third ratchet positioned at least partially within the third ratchet pocket.

12. A pretensioning retractor comprising:
- a shaft extending along an axis through at least a portion of the retractor;
- a gear operably coupled to the shaft;
- a spool coupled to the shaft and configured to receive a strap of a restraint harness;
- a hub rotatably coupled to the shaft and having a ratchet pocket;

a ratchet having a pin and a ratchet tooth, wherein the ratchet is positionable at least partially within the ratchet pocket with the pin extending at least generally parallel to the axis and the ratchet tooth positioned to selectively engage the gear;

a cable coupled to the hub and operable to rotate the hub, wherein rotation of the hub engages the ratchet tooth with the gear to rotate the shaft and the spool and retrieve at least a portion of the strap; and

a tab having a cable opening, wherein the cable extends from the hub through the cable opening.

13. A pretensioning retractor comprising:

a shaft extending along an axis through at least a portion of the retractor;

a gear operably coupled to the shaft;

a spool coupled to the shaft and configured to receive a strap of a restraint harness;

a hub rotatably coupled to the shaft and having a ratchet pocket;

a ratchet having a pin and a ratchet tooth, wherein the ratchet is positionable at least partially within the ratchet pocket with the pin extending at least generally parallel to the axis and the ratchet tooth positioned to selectively engage the gear, wherein the ratchet includes a detent, wherein the hub includes a set screw, and wherein the set screw engages the detent to maintain a rotational position of the ratchet in relation to the ratchet pocket; and

a cable coupled to the hub and operable to rotate the hub, wherein rotation of the hub engages the ratchet tooth with the gear to rotate the shaft and the spool and retrieve at least a portion of the strap.

14. A restraint system pretensioner assembly comprising:

a seat positionable within a vehicle and having a stroking device configured to enable vertical motion of the seat;

a retractor associated with the seat and having a spool configured to be operably coupled to a harness;

a loading mechanism associated with the seat and having a pivotable arm; and

a pretensioning cable assembly having a pretensioning cable operably coupling the loading mechanism to the retractor, wherein the pivotable arm is configured to rotate in response to downward motion of the seat relative to the vehicle and retract the pretensioning cable, thereby rotating the spool and retracting at least a portion of the harness.

15. The restraint system pretensioner assembly of claim **14**, further comprising a locking cable assembly having a locking cable, wherein the pivotable arm is rotatable to move at least a portion of the locking cable to prevent payout of the harness.

16. The restraint system pretensioner assembly of claim **14** wherein the loading mechanism includes a pulley operably coupled to the pivotable arm, wherein the pretensioning cable is positioned to engage the pulley, and wherein rotation of the pivotable arm includes motion of the pulley to retract the pretensioning cable.

17. The restraint system pretensioner assembly of claim **14** wherein the retractor includes a shaft and a hub, wherein the spool is fixedly attached to the shaft, wherein the hub is rotatably coupled to the shaft, wherein the pretensioning cable is coupled to the hub, and wherein retraction of the pretensioning cable rotates the shaft and the spool via rotation of the hub.

18. The restraint system pretensioner assembly of claim **14** wherein the retractor includes a shaft and a plurality of ratchets, and wherein retraction of the pretensioning cable includes rotation of the shaft via rotation of the plurality of ratchets.

19. The restraint system pretensioner of claim **14**, further comprising means for locking the retractor to prevent payout of the harness.

20. The restraint system pretensioner of claim **14**, further comprising:

a shaft extending along an axis through at least a portion of the retractor, wherein the spool is fixedly attached to the shaft;

a gear operably coupled to the shaft; and

means for rotating the shaft via the gear.

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